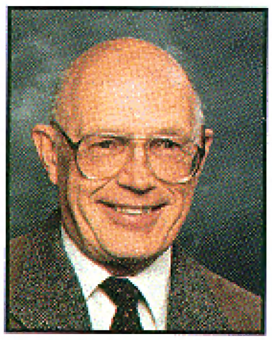
Shaft CenterLINES

How to handle (and some cases of) forward and reverse orbits



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The classical response of a rotor system is a circular and forward (in the direction of rotation) orbit. For many reasons, however, the orbit may be elliptical or flat, or even reverse elliptical or a reverse circle. The simplest and predominant reason for such orbits (but by no means exclusive) is nonsymmetric (anisotropic) support stiffness of the rotor system.

The asymmetry could be in the bearing (such as more horizontal than vertical clearance, or by vertical steady sideload), or it could be in the support structure of the bearing. Typically, most horizontal machines are weaker horizontally than vertically for all three reasons noted herein.

Here is a very simple rotor system (Figure 1) with a horizontal bearing stiffness much lower than the vertical bearing stiffness. Figure 2 shows the Bode plots of rotative speed vertical and horizontal dynamic motion (vibration) behaviors. The phase angle portion of the Bode plot makes the description of the forward and reverse orbiting very simple and straightforward. As you may observe, the rotor vibrates in reverse in the period between the two resonances.

The orbits for various speeds are also shown on the figure.

Next, observe the polar plots of this same rotor (Figure 3). Note that the polar plots for the vertical and horizontal are grossly different from the polar plots

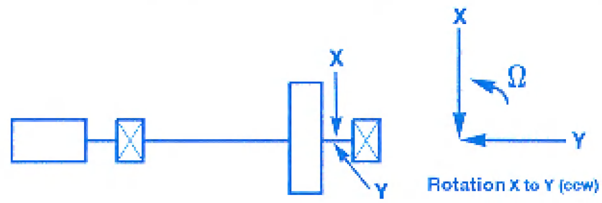

Figure 1

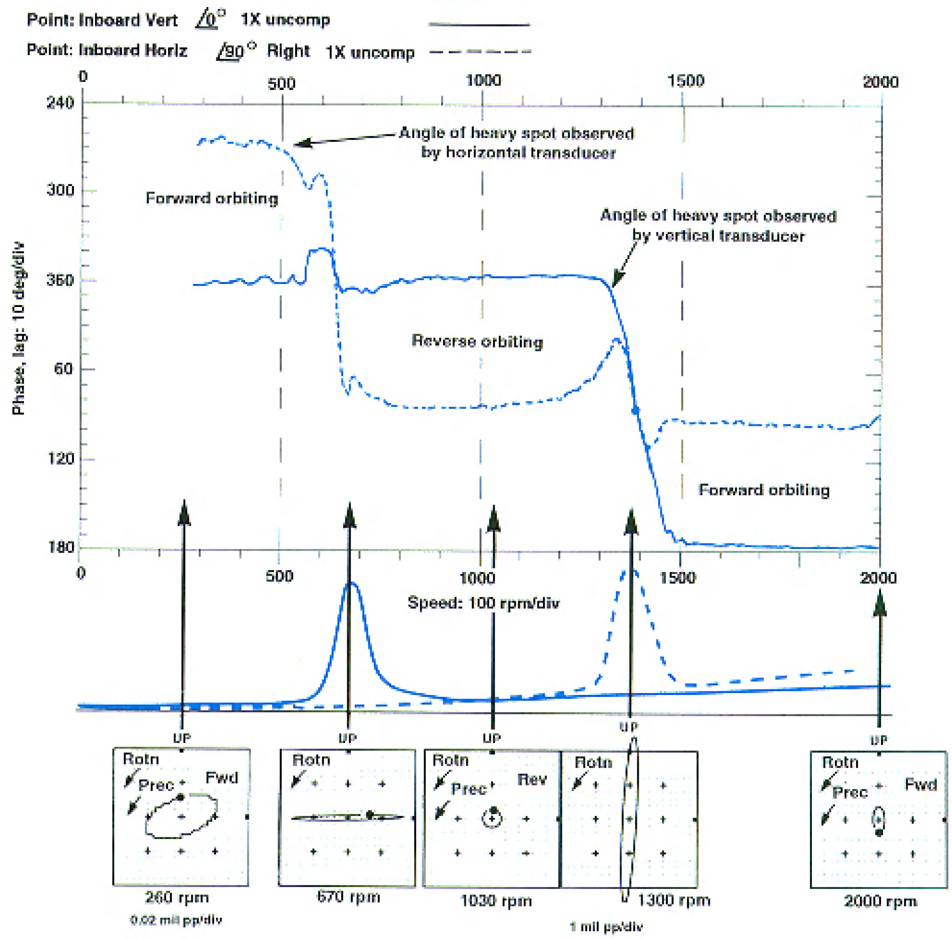

Figure 2

of the 45° left up and 45° right up probes. The bottom line of this story is that, when you find Bode or polar plots which show the "split resonance effect" of:

a) in a Bode plot, a double hump or a broad hump and a weird phase behavior, or

b) in a polar plot, an internal loop, then, to read the machine behavior properly, you must coordinate rotate the probe reading until the internal loop of the polar plot disappears. This yields polar plots showing the resonant frequency of each axis and the angle of the weaker axis and the stiffer axis.

Of course, this rotation of the probe angle does not work for two different lateral balance resonance modes, except to yield the angle between the unbalances for each mode, which is about useless. Be sure to remember that, while the description above accounts for many elliptical orbits, there may be other reasons for those elliptical orbits, such as a mechanical resonance of a casing part or even of the shaft relative dynamic motion observing probes.

Editor's note: *Bently Nevada has a new convention for indicting shaft rotation direction. Please see X to Y and Y to X on page 27.*

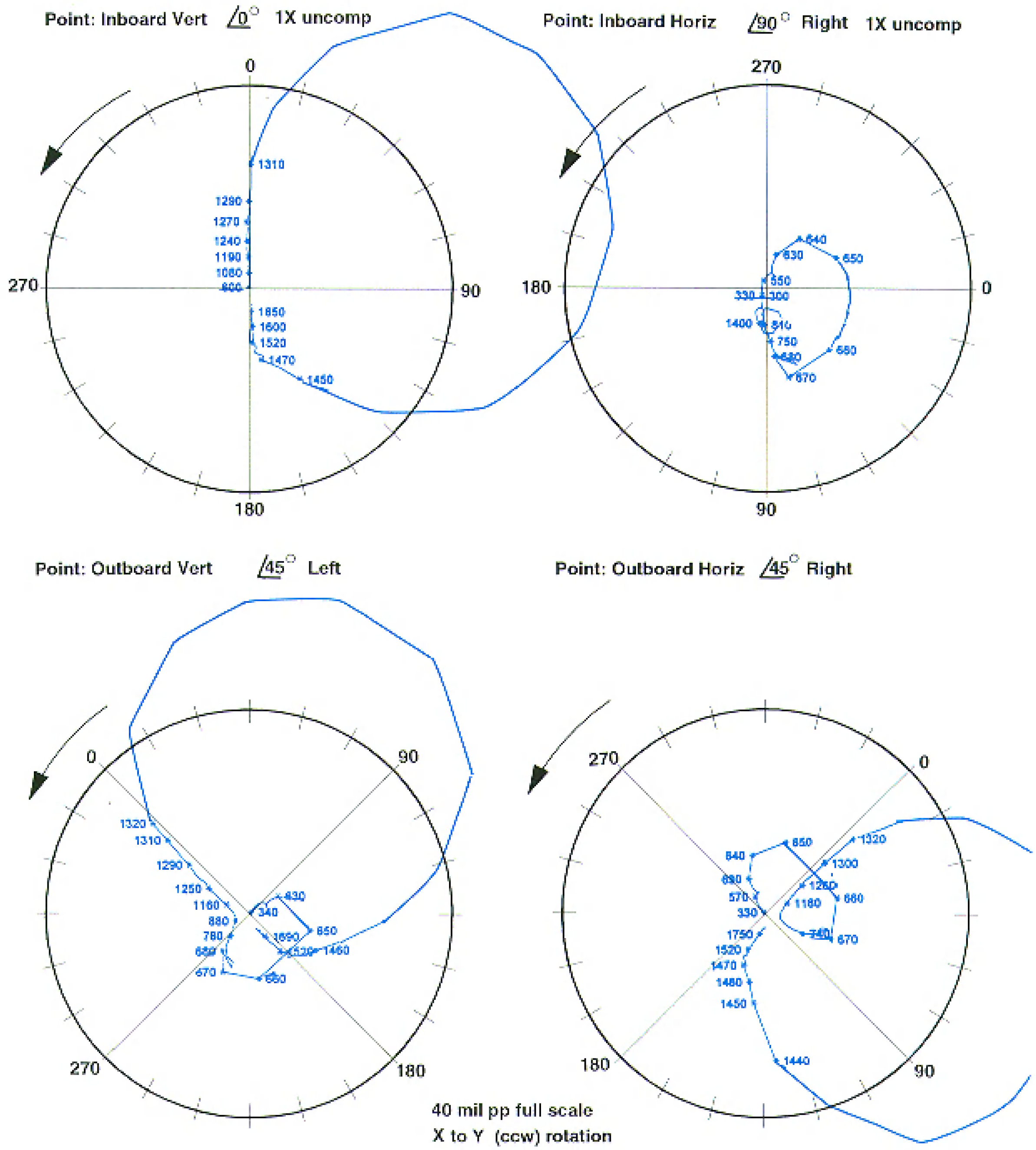

Figure 3